

**Forest insect and disease conditions
British Columbia & Yukon
1984**

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Abstract

This summary of forest pest conditions in British Columbia and the Yukon in 1984 was compiled from records and field reports of 11 Forest Insect and Disease Survey technicians. Emphasis is on damaging pests that are, or may become, major management problems. Thirty-nine forest pests are discussed in detail and some predictions are made for 1985. Mountain pine beetle killed 482 000 ha of mature pine, mainly in the Cariboo Region. Spruce beetle infestations in the Prince George and Prince Rupert regions declined to 46 300 ha. The area of Douglas-fir forests defoliated by western spruce budworm declined to 62 000 ha. Douglas-fir tussock moth populations collapsed to only 160 ha following three years of the most severe and expansive recorded outbreaks. A new outbreak of eastern spruce budworm defoliated 7 300 ha of fir-spruce stands in the Liard River Valley. Western hemlock looper infestations expanded in the Cariboo and Kamloops regions to 13 350 ha, but collapsed in the Nelson Region following two years of severe defoliation. Increased western blackheaded budworm populations lightly defoliated 19 000 ha old growth western hemlock and western red cedar in the Revelstoke area. Gypsy moth adults were trapped on Vancouver Island, for the second consecutive year, and on the Lower Mainland.

Résumé

Cet aperçu des conditions relatives aux ravageurs forestiers en Colombie-Britannique et au Yukon en 1984 a été établi à partir des données et des rapports d'observation sur le terrain de 11 techniciens du Relevé des insectes et des maladies des arbres. On a accordé une importance particulière aux ravageurs qui représentent ou risquent de causer des problèmes importants de répression. Trente-neuf ravageurs des forêts sont examinés de façon détaillée, et des prévisions sont présentées pour 1985. Le dendroctone du pin ponderosa a tué des pins à maturité sur 482 000 ha. Les infestations par le dendroctone de l'épinette ont été réduites à 44 000 ha. La défoliation des forêts de douglas taxifolié par la tordeuse occidentale de l'épinette a également diminué, atteignant 62 000 ha. Les populations de la chenille à houppes du douglas se sont effondrées après une pullulation de trois ans. Par contre, une nouvelle pullulation de la tordeuse des bourgeons de l'épinette dans la vallée de la Liard a défolié 7 300 ha de peuplements de sapin et d'épinette. Les infestations de l'arpenteuse de la pruche de l'Ouest ont progressé dans le centre de la Colombie-Britannique où elles ont sévi sur 13 350 ha, mais se sont effondrées dans la région de Nelson après deux ans de défoliation grave. Les populations, en hausse, de la tordeuse à tête noire de l'Ouest ont défolié légèrement 19 000 ha de pruche occidentale et de thuja géant à maturité. Pour la deuxième année de suite, des spongieuses adultes ont été capturées dans l'île Vancouver; des captures ont également été faites dans les basses terres de la partie continentale.

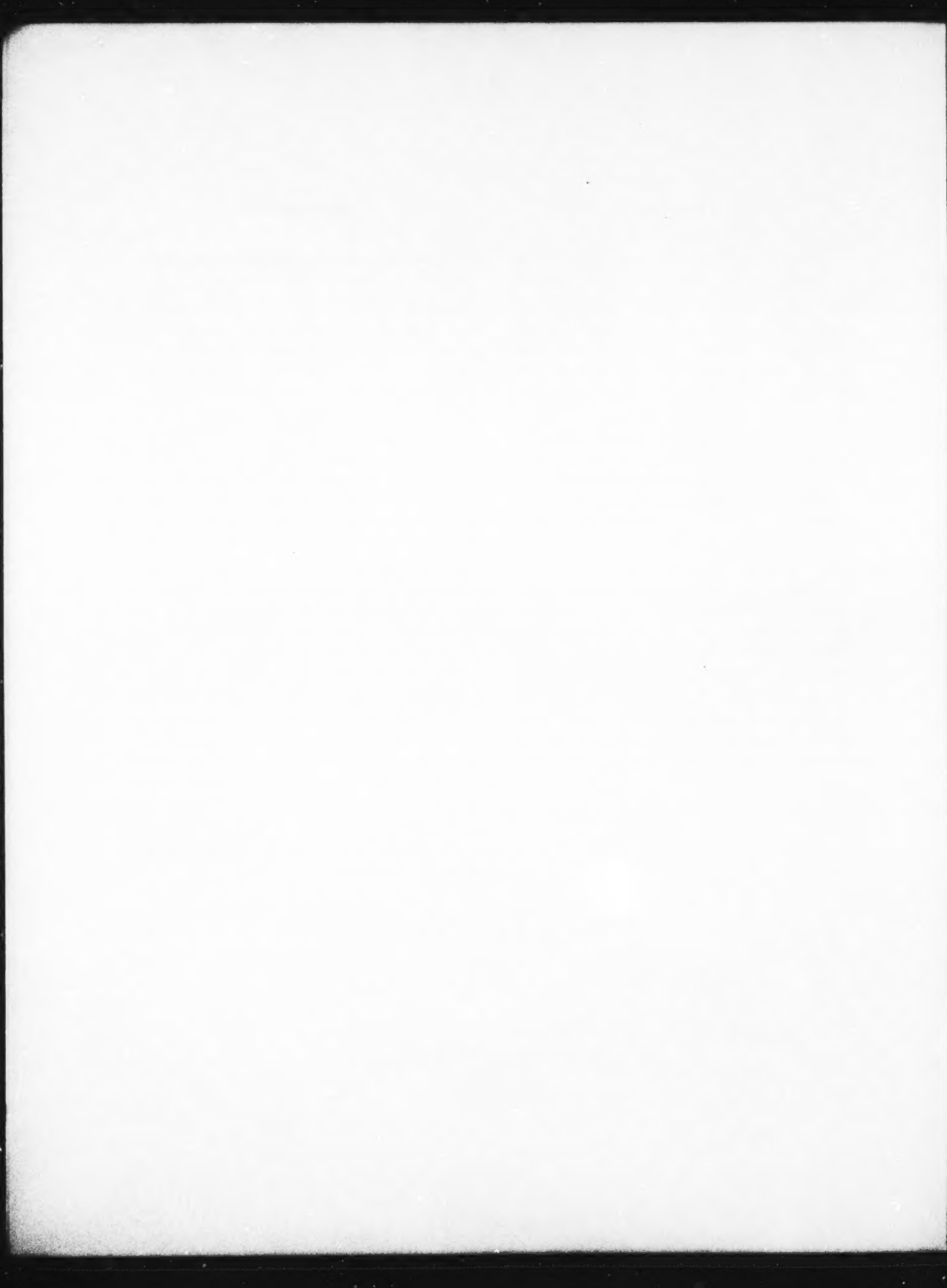


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INTRODUCTION

The six Forest Insect and Disease Survey units of the Canadian Forestry Service are responsible for producing a national overview of important pest conditions and their implications; maintaining records and surveys to support quarantines; supporting forestry research through maintenance of records, herbaria, and insect collections; and providing advisory services concerning forest insect and disease conditions. General surveys to detect and monitor important insects and diseases are conducted annually in the Pacific Region with the cooperation of the British Columbia Ministry of Forests and other federal, provincial, industrial, and municipal agencies. The close cooperation with research programs and staff at the Pacific Forest Research Centre continues to be an important contribution.

This regional report reviews the impact and status of major forest insects and diseases throughout British Columbia and the Yukon Territory in 1984 and forecasts some pest conditions for 1985. The information is compiled primarily from the observations and field records of eleven Forest Insect and Disease Survey Rangers during their field assignments extending from late May to October. More detailed information for each provincial forest region is available in file reports compiled by the following rangers.

Cariboo Forest Region

— Dick Andrews

Kamloops Forest Region

— Bob Erickson; Bob Ferris

Nelson Forest Region

— Peter Koot; Rod Turnquist

Prince George Forest Region

— Rod Garbutt; Jim Loranger

Prince Rupert Forest Region

— Leo Unger; Nick Humphreys

Vancouver Forest Region

— Roly Wood; John Vallentgoed

Other staff of the Forest Insect and Disease Survey project in 1984 were as follows:

- Bob Duncan, Insectary Technician
- David Evans, Entomologist i/c Insectary and Collection
- John Hopkins, Pathologist i/c Herbarium
- Daphyne Lowe, Herbarium Technician
- Erika Pass, Insectary Technician
- Terry Shore, Pest Survey Sampling Officer
- Walter Stanek, Mensuration
- Joan Strobbe, Secretary
- Allan Van Sickle, Head of the Forest Insect and Disease Survey Unit
- Colin Wood, Chief FIDS Ranger

SUMMARY

Tree and insect development was delayed by 2-4 weeks and foliar diseases intensified following near-record cool temperatures, subnormal amounts of sunshine and higher than normal precipitation in May and June. This followed generally normal winter weather but high winds in April caused extensive windthrow and breakage of mature white spruce and lodgepole pine in the central and northwestern Interior. Although July and August were relatively sunny and dry, insect development was later than normal.

The most significant insect problem of mature forests in British Columbia continued to be **mountain pine beetle**, which since 1972 has killed more than 175 million lodgepole pine. An estimated 41 million trees (12.1 million m³) were killed over 482 000 ha, up slightly from 1983. Most infestations, mainly in the Cariboo and Kamloops regions, continued to intensify and expand.

Spruce beetle infestations, mainly in the Prince George and Prince Rupert regions, declined for the second consecutive year to 46 320 ha (1.7 million m³) from 58 600 ha (3.3 million m³).

In parts of the Queen Charlotte Islands and some coastal areas of the Prince Rupert Region, increased **spruce aphid** populations killed up to 4% of the immature and seedling Sitka spruce, and moderately to severely defoliated most other age classes.

The area of Douglas-fir forest defoliated by **western spruce budworm**, mainly in the Kamloops and Cariboo regions, declined 16% to 62 000 ha of mainly light and moderate feeding. A localized area was affected in the Nelson Region. For the fourth consecutive year defoliation did not occur in the Vancouver Region.

Douglas-fir stands defoliated by **Douglas-fir tussock moth** declined from 23 475 ha in 1983 to only 160 ha near Cherry Creek west of Kamloops. Previously active infestations in the Cariboo, Nelson and Vancouver Regions col-

lapsed. The decline, caused by a naturally occurring nuclear polyhedrosis virus and parasites, severely reduced the number of egg masses in 1983. Tree mortality of mainly immature trees, severely defoliated for up to two years, covered 5 500 ha from Cache Creek to Falkland. **Douglas-fir beetle** attacked severely defoliated Douglas-fir near Falkland.

A new outbreak of **eastern spruce budworm** lightly defoliated 7 300 ha in the Liard River Valley. A **one-year cycle budworm** expanded to 2 700 ha of alpine fir-spruce in the Kitimat-Terrace area of the Prince Rupert Region, but populations in the eastern part of the Region collapsed due to a pathogen. Light defoliation of fir and spruce by two-year cycle budworm occurred over 2 000 ha in the Bowron and Willow river drainages in the Prince George and Cariboo regions and 200 ha in the Nelson Region.

Defoliation of western hemlock and western red cedar stands in the Nelson Region by **western hemlock looper** declined to only 100 ha in this third year of infestation. As predicted, parasitism which affected up to 34% of the 1983 overwintering eggs, was the major cause of the population collapse, similar to trends in previous outbreaks. However, localized infestations in the Kamloops Region almost doubled to 8 000 ha of mainly light defoliation, and 5 250 ha were lightly to severely defoliated in the Cariboo Region, following a 2 year population buildup.

For the first time since 1975 **western blackheaded budworm** defoliated mature and overmature western hemlock and western red cedar stands in the Interior wet belt. Following a 2 year population buildup, about 19 000 ha of mainly light and moderate defoliation occurred in 240 pockets from Glacier National Park north to Goldstream River in the Nelson Region. Most budworm infestations were in or adjacent to stands recently defoliated by western hemlock looper.

An estimated 41 000 ha of western larch stands between Creston and Elko in the Nelson Region

were severely discolored by increased **larch case-bearer** populations. Populations remained at low levels in larch stands in the West Kootenay due in part to periodic releases of introduced parasites. **Larch budmoth** defoliated 1 100 ha in 10 widely scattered stands near Trail and Rossland, a decrease from 1983. More than 3 000 ha of western larch in the East Kootenay were moderately to severely defoliated by **larch sawfly** in the third year of infestation, down significantly from 10 400 ha in 1983.

High numbers of **black army cutworm** larvae mined up to 35% of the buds and lightly to severely defoliated spruce and Douglas-fir seedlings in six newly planted sites in the Cariboo, Prince George and Prince Rupert regions. Seedling mortality (10%) was evident in a plantation north of Prince George but most larval feeding was restricted to herbaceous ground cover. Some planting schedules were adjusted.

Several quarantine related surveys were conducted:

- Follow-up inspections were negative for **terminal crook disease** of western hemlock seedlings at three 1981 planted sites on Vancouver Island.
- **Gypsy moth** was recorded for the second year at Courtenay, numerous larvae were found and 25 moths trapped. Elsewhere, two moths were trapped in East Vancouver, four at Chilliwack, one at Cultus Lake and one at Adams River east of Kamloops.

Moths were not recorded by FIDS in pheromone-baited traps in forested recreation sites through the province.

- Surveys of 8 border stands for **balsam woolly aphid** north of the recent record in Idaho, were negative.
- Examinations for **European pine shoot moth** in native pines in the Okanagan Valley and parts of the West Kootenay were negative.
- Surveys for **European larch canker** were negative, but two closely related native saprophytic canker fungi were collected in southeastern British Columbia.
- Although the **pinewood nematode** was not detected in lodgepole pine samples or in cerambycid beetles which transmit the nematode, some native bacterial and plant pathogenic nematodes were present.

Permanent plots to detect and then monitor early signs of **acid rain** were established at Shawnigan Lake, Saltspring Island and the U.B.C. Research Forest near Haney. In addition, tree condition was assessed on 417 FIDS Permanent Sampling Areas throughout the province.

In support of the Environment 2000 projects administered by the C.F.S., pest conditions were assessed at 17 forest improvement sites in the Kamloops, Nelson, Prince Rupert and Vancouver regions.

PINE PESTS

Mountain pine beetle *Dendroctonus ponderosae*

The most damaging pest in British Columbia in 1984 continued to be the mountain pine beetle. Since 1972 an estimated 175 million mature pine have been killed by the beetle in the province (Fig. 1), where pine stands cover more than 14 million ha and comprise 22% of the harvest.

Mature lodgepole pine and some western white pine killed by the 1983 beetle attack covered more than 482 000 ha (see map 1), up slightly from last year. More than 7 500 infestations, from the International border in the East Kooten-

ay to north of Hazelton, contained an estimated 12.1 million m³ of beetle-killed trees (Table 1), about 18% of the 1982-83 provincial harvest. Losses were greatest in the Cariboo, Kamloops, Nelson and Prince Rupert regions and also occurred in the Prince George and Vancouver regions.

Increases in areas of pine mortality, mainly in the Kamloops, Prince George and Vancouver regions and to a lesser degree in the Nelson and Prince Rupert regions, occurred as a result of general expansion of previously infested stands. In addition, nearly 170 000 ha with 'grey' previously killed pine stands were mapped; 85% in the Cariboo.

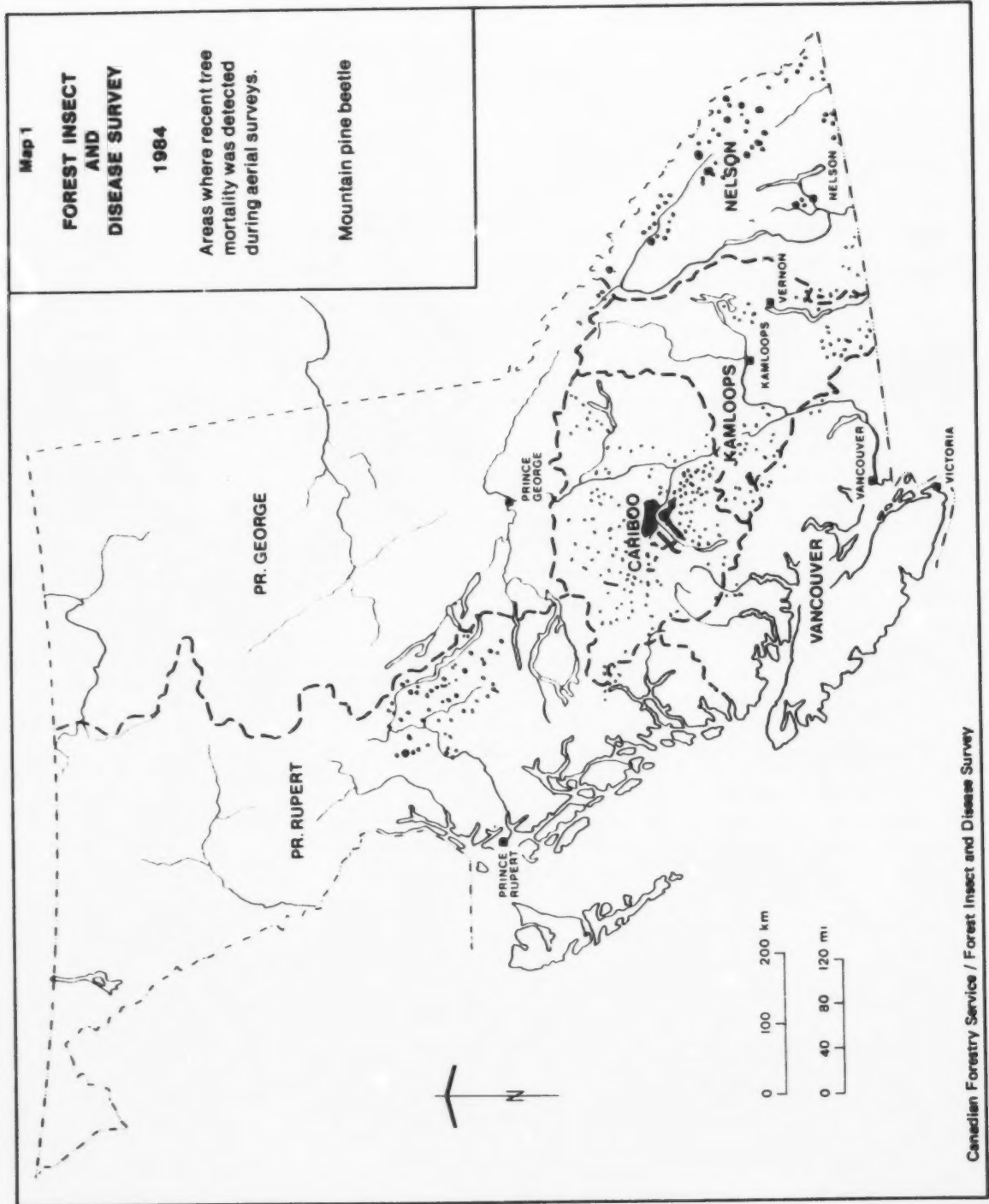
Table 1. Number and area of mountain pine beetle infestations by provincial Forest Regions, based on recently killed trees observed during aerial surveys and on limited ground observations, British Columbia, 1984.

Region	No. of infestations	Area (ha)	Trees Killed ^a		Stands Cruised	Average % of Trees ^b				
			Number (000)	Volume (000 m ³)		H	C	R	G	P
Cariboo	5 000	381 000 ^c	33 000	7 600	20	55	24	12	8	1
Kamloops	600	58 000	5 000	2 734	9	66	15	7	10	2
Nelson	1 350	21 000	1 800	600	7	77	7	3	8	5
Prince George	150	2 800 ^c	270	97	—	—	—	—	—	—
Prince Rupert	650	14 500 ^c	1 212	1 103	14	40	24	18	10	8
Vancouver	20	5 000	20	—	—	—	—	—	—	—
TOTAL	7 770	482 300	41 302	12 194	50	60	17	10	9	4

^a Trees attacked in 1983, discolored in 1984.

^b H = Healthy; C = Current, attacked in 1984; R = Red, attacked in 1983; G = Grey, attacked prior to 1983, P = Partial attack (strip attack).

^c Estimates include data from B.C. Ministry of Forests.



boo Region, and the balance in the Nelson Region.

Based on surveys in 50 areas, most infestations are expected to expand and intensify in 1985. An average of 17% (1 to 65% range) of the standing green trees were currently attacked, down 5% from 1983.

Early in 1984, pre-emergency brood assessments in 31 stands in the Cariboo, Kamloops and Nelson regions indicated increasing populations in most major infestations, but a probable decline in parts of the Prince Rupert Region. The ratio of successful overwintering progeny to parent beetles ranged from 0.6 to 12.8; a factor greater than 4.1 indicates a rising population. A slight decrease in current attack in higher elevation stands occurred in parts of the Prince Rupert Region due to mortality of up to 75% of the beetle populations during the winter of 1983-84. The majority of the broods from 1984 flights developed normally in the Cariboo, Kamloops and Nelson regions. In the Prince Rupert Region brood development was normal in lower elevation and southern exposed stands. However, about half the pine which contained 1984 broods had been attacked in 1983, and 1½- to 2-year cycle broods from late 1983 attacks were common.

Outbreaks in the Cariboo Region affected 318,000 ha, similar to 1983, and contained more than 33 million trees (7.6 million m³). This represents 80% of the total provincial outbreak area and more than 13 times the average area logged of all species in the region annually. In addition, more than 144 000 ha contained 6.6 million m³ of previously beetle-killed lodgepole pine. The major expansion of widespread outbreaks was northward from Alexis Creek and Tatla Lake to Nazko and Anahim Lake. Current attack in 20 recently infested stands west of Riske Creek averaged 24% (range 2 to 65%), down from 31% in 1983. The highest average incidence of current attack was 65% at Mons Lake southwest of Riske Creek and 47% on the Taseko Lake Road. Elsewhere in the region current attack ranged from 2 to 29% (avg. 20%) in 18 stands. This indicates continuing high levels of lodgepole pine mortality in 1985, the eleventh consecutive year of infestation.

An estimated 600 infestations in the Lillooet and Okanagan TSAs in the Kamloops Region con-

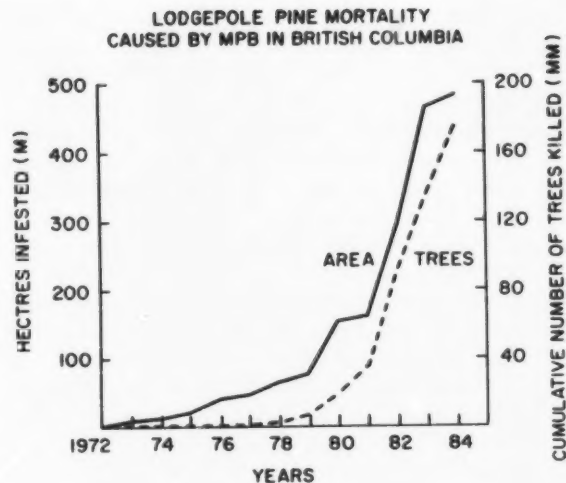


Figure 1. Annual area of aerially visible, recent tree discoloration and cumulative number of trees killed by mountain pine beetle, 1972-1984.

tained 5 million trees (2.7 million m³) over 58,000 ha, up 24% from 1983. Areas of mortality expanded in chronically infested stands near Carpenter Lake, Goldbridge, Tyaughton and French Bar creeks. Major infestations continued in Mission and Belgo creeks east of Kelowna, in Lambly, Shorts, Trout and Hayes creeks west of the Okanagan Valley, in the Ashnola River Valley and in the Stein River Valley west of Lytton. Continuing outbreaks and increased mortality are expected in most areas in 1985, based on an average of 15% current attack in eight representative stands, down slightly from 18% in 1983. The highest incidence of current attack was 50% at Hayes Creek near Princeton.

Infestations in the Nelson Region covered an estimated 21 000 ha which contained about 1.8 million (600 000 m³) lodgepole and some white pine in 1350 widespread infestations. Additionally 25 000 ha contained mainly dead trees from previous years of infestation. Host depletion from previous beetle attacks and harvesting has limited the expansion of infestations particularly in the Flathead River Valley and the Bush Arm area north of Golden. However, infestations continued elsewhere, including the Caven-Bloom creeks area near the Montana border, the White and Kootenay river drainages along the Alberta border, Kootenay National Park and the Colum-

bia and Kettle river valleys. Spot infestations of 2 to 45 trees expanded in 7 of 15 valleys along the B.C./Alberta border from Elkford to north of Golden, remained static in 6 and 2 declined. Continuing but declining outbreaks and tree mortality are expected in 1985, indicated by 7% current attack in seven stands, similar to 1983 levels. The highest incidence of attack was 17% near Christina Lake and 16% near Dutch Creek.

The area, number and volume of lodgepole pine killed in the Prince Rupert Region increased slightly to 1.2 million trees (1.1 million m³) on 14 500 ha up from 13 300 ha in 1983. The increases occurred mainly in the Cranberry River drainage and in the Skeena River drainage between Hazelton and Terrace where aerial survey coverage was expanded in 1984. Major outbreaks continued in Harold Price Creek, Morrison, Fulton and Babine lakes areas and in the Nass River drainage. Outbreaks are expected to continue throughout the Region in 1985 based on trees currently attacked which averaged 24% (range 5 to 46%) in 15 infested stands, down slightly from 28% in 1983. The regional current attack remains high, particularly in the Kispiox area (46%), despite mortality of up to 75% of the overwintering eggs and early instar larvae in higher elevation stands in the eastern interior.

In the Prince George Region an estimated 15 000 lodgepole pine were killed over about 225 ha in the Fort St. James area. Also, mortality of lodgepole pine and some western white pine covered 2 600 ha in chronic infestations in mature stands in the Canoe Arm area south of Valemount.

Widespread, scattered infestations increased by more than half in the Vancouver Region to 20 000 recent beetle-killed trees in 20 areas over 5 000 ha. The major expansion occurred in the Homathko River drainage, west of extensive outbreaks on the Cariboo Region. Elsewhere small infestations occurred in the Pemberton and Fraser Canyon areas. A cooperative beetle control program in Manning Provincial Park has reduced the number of beetle-infested trees from 5 500 in 1981 to only three in 1984. However, a threat of reinvasion exists from east of the Park where 40 groups of 5-10 recently killed lodgepole pine indicate a continuing population buildup.

Needle diseases

Native needle diseases increased in most interior pine stands. Severe, conspicuous discoloration of 1983 needles of lodgepole, white and ponderosa pines was widespread in the Kamloops, Nelson and Prince Rupert regions, and to a lesser degree in the Prince George and Vancouver regions. Favorable, moist conditions during spore dispersal and infection in 1983 also occurred in 1984. This could result in moderate to severe infections again in 1985. Infection declined significantly in the Cariboo Region following two successive years of moderate to severe infection and needle loss.

Red band needle disease, *Scirrhia pini* was the most common disease on needles of lodgepole and white pine and was often associated with needle blights *Lophodermella concolor* and *L. montivaga*. Western pine-aster rust *Coleosporium asterum* was common in a few areas. Ponderosa pine was most commonly infected by *Elytroderma* needle disease, *Elytroderma deformans* and a needle blight *Leptomelanconium cinereum* was common in patches in the Nelson Region.

Increased infection of most age classes of lodgepole and white pine by *S. pini* was widespread in the Nelson Region. Up to 80% (avg. 50%) of the 1982 and 1983 needles of most lodgepole pine were infected at Beaverdell, in the West Kettle and Slokan river valleys, and near Salmo, Creston, Invermere and Sparwood. This was the third consecutive year of severe infection and discoloration in many immature white pine stands in the Slokan Valley.

In the Kamloops Region widespread moderate infections of lodgepole pine by *L. concolor* and *L. montivaga* also increased, particularly in the Thompson River drainage. The areas of lodgepole pine affected in the Blackwater, Fort St. James, Vanderhoof and Fraser Lake areas in the Prince George Region generally declined slightly from 1983, and trees were less severely infected. However, pines in provenance trials at Red Rock were severely infected for the second year. North of Hazelton in the Prince Rupert Region 75% of the needles on 10% of the young lodgepole pine were infected and discolored. For the second successive year immature lodgepole pine on Vancouver Island were lightly to moderately infected near Parksville and at the south end of Buttle

Lake. Infection in lower elevation mature pine stands near Lightning Lake in Manning Park increased to moderate and severe.

Elytroderma needle infections on ponderosa pine increased throughout much of the host range for the third consecutive year, with systemic infection often resulting in severe brooming. Up to half (avg. 30%) of the year-old needles were infected on most of the trees over widespread areas from the Okanagan Valley to Kamloops. Severely infected stands were common from Anarchist Mountain to Midway and near Creston in the Nelson Region.

Infection of previous year's needles of ponderosa pine by *L. cinereum* in the Koocanusa area in the Nelson Region were common but lighter than in 1983. In localized stands 25% of the needles on most trees were infected, and repeated annual infections since 1979 have resulted in significant needle loss. Vigor reduction, increment loss and predisposition of trees to secondary bark beetle attacks could result.

Pine engraver beetle

Ips pini

Increased current attacks in recently windthrown mature lodgepole pine ranged from 5 to 10 per 1000 cm² of stem surface area in the Nazko, Palmer and Puntzi lakes areas in the Cariboo Region. Sixty percent of the slash was infested in a recently thinned stand near Cedarvale in the Prince Rupert Region.

Following one or two years of population build-up, patches of healthy trees are often attacked and killed. This could occur in some of these areas in 1985.

A pine sawfly

Neodiprion sp.

For the second consecutive year, increased sawfly populations severely defoliated most age classes of shore pine in the Masset Sound area of northern Graham Island on the Queen Charlotte Islands. At Nache Creek infestations expanded from about 20 ha to about 200 ha. Defoliation is not expected to occur in 1985 as infestations usually decline following one or two years of defolia-

tion. Heavy mortality of shore pine on coastal islands was reported in 1977 following severe defoliation in 1975.

Pinewood nematode

Bursaphelenchus (lignicolus) xylophilus

This nematode, responsible for mortality of pines over large areas in Japan during the past 30 years, was recently discovered in Manitoba and the United States. Surveys of pine stands in British Columbia for this nematode were negative for the fourth consecutive year.

Although 25 lodgepole pine samples and three adult cerambycid beetles, which transmit the nematode from dead to live pines, did not contain *B. xylophilus*, native bacterial feeding and plant pathogenic nematodes were successfully isolated from coastal and interior pine stands.

Branch flagging and dead mature lodgepole pine were observed adjacent to recently harvested stands at Luno Creek and in the Zymoetz River Valley in the Prince Rupert Region. A causal agent was not identified.

European pine shoot moth

Rhyacionia buoliana

Since specific surveys for the introduced pest were concluded in 1981, damage or spread to natural pine stands has not been observed from the adjacent, previously infested exotic pines in the Kamloops and Nelson regions.

SPRUCE PESTS

Spruce beetle

Dendroctonus rufipennis

Chronic infestations, mainly in the Prince George and Prince Rupert regions and localized in the Cariboo, Kamloops and Nelson regions (see map 2), declined 14% overall to 46 320 ha (1.7 million m³) of mature white and Engelmann spruce killed by 1982-83 beetle attack (Table 2). This second year of decline, largely in the Prince George and Cariboo regions and to a lesser degree in the Prince Rupert Region, was due mainly to harvesting, trap tree programs and host depletion. However, small increases occurred in isolated parts of the Kamloops and Nelson regions.

Surveys in 19 stands indicate an overall reduction of new attacks to 5% (range 0 to 22%) of the trees in the stand, down from 13% in 1983. Extensive areas of recent spruce blowdown in northcentral B.C. absorbed much of the current year's attack

in the Prince Rupert Region. This could contribute to increased populations and tree mortality if not salvaged before 1986. Broods in 1984-attacked standing trees in the cruised areas were predominantly two-year cycle and less vigorous than in previous years.

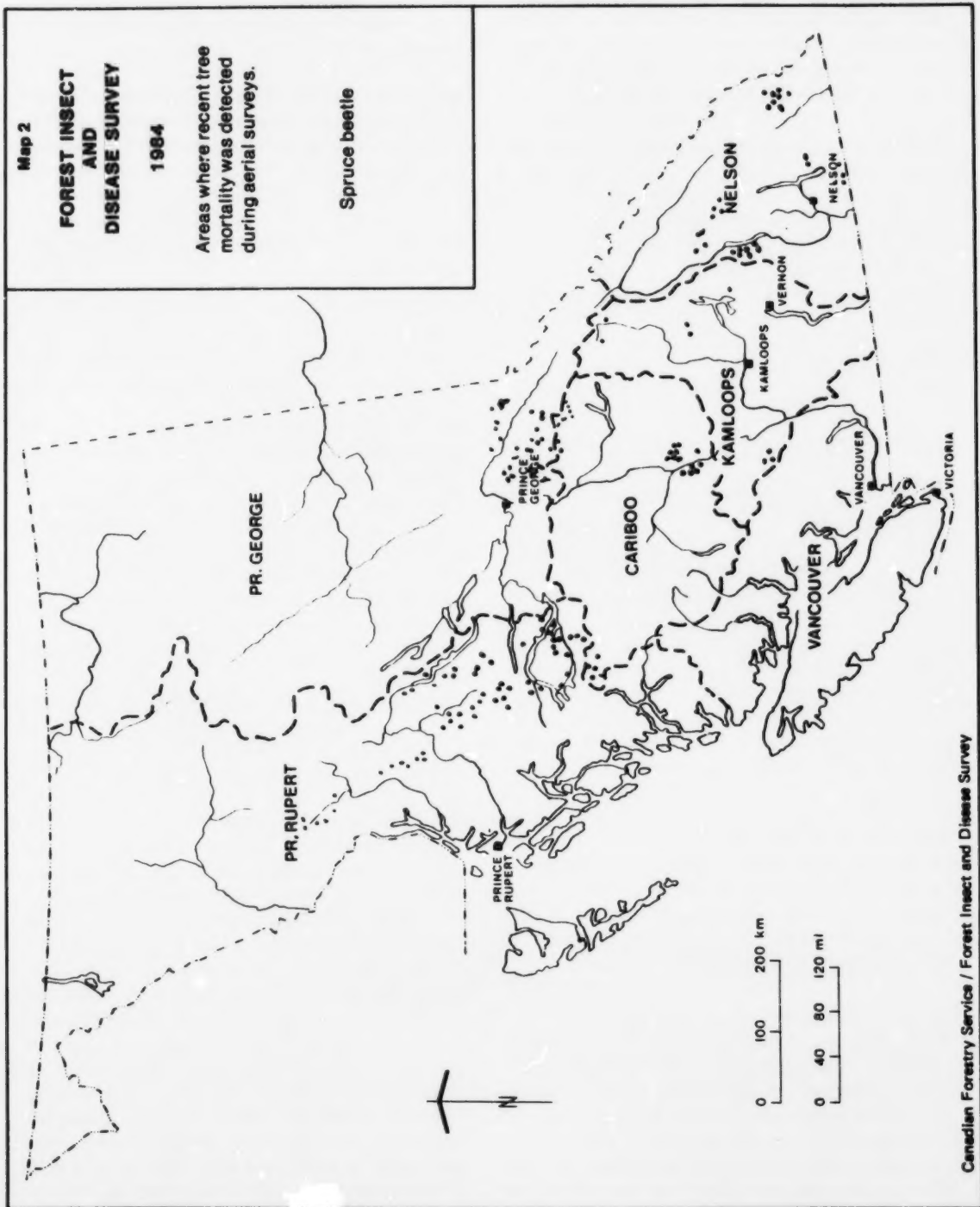
Recent mortality of mature spruce in the Prince George Region declined 25% overall to 26 120 ha (523 700 m³). The decline was mainly in the Bowron and McGregor river drainages, however in the Goat River drainage the area of the mortality increased 7 fold to 2 250 ha. The volume of spruce harvested in beetle-infested stands in the Bowron River Valley totalled an estimated 9 million m³ during the past three years. In surveys of three previously infested stands in the Bowron River drainage, current attack was not evident. This is attributed to the greatly reduced emergence of broods from previously infested trees. Beetle populations in other stands in the Region which were not examined are expected to contin-

Table 2. Number and area of spruce beetle infestations by provincial Forest Region based on recently killed trees observed during aerial surveys and limited ground observations, British Columbia, 1984.

Region	No. of Infestations	Area (ha)	Volume killed (000 m ³)	No. of Stands Cruised	Average % of Trees ^a				
					H	C	R	G	P
Cariboo	6	2 200	22	—	—	—	—	—	—
Kamloops	9	700	1	—	—	—	—	—	—
Nelson	115	3 700	116	1	77	7	3	8	5
Prince George	490	26 120 ^b	524	3	45	0	15	25	15
Prince Rupert	400	13 600 ^b	1 116	15	47	8	17	14	14
TOTAL	1 020	46 320	1 779	19	57	5	12	15	11

^a H = Healthy, C = Current, attacked in 1983; R = Red, attacked in 1981-82; G = Grey, attacked prior to 1981; P = Partial attack

^b Estimates include data from B.C. Ministry of Forests



ue, but at reduced levels.

Infestations in Bowron Lake Provincial Park in the Cariboo Region declined for the second year by nearly half to 2 200 ha. The decline reduced the number of widely scattered infested stands to six along the eastern park boundary.

Mortality occurred in 400 infestations in the Prince Rupert Region, where 13 600 ha of mature spruce were killed by 1982-83 beetle attacks, down 18% from 1983. The largest areas of tree mortality, mainly in chronically infested stands, were in the Morice, Fulton and Bell-Irving river drainages and near Ootsa Lake. Tree mortality is expected to continue in 1985 but at reduced levels. Currently attacked trees ranged from 3 to 22% in 15 stands. The decline in current attack in standing green trees is mainly the result of the attraction of the 1984 beetle flight to recent widespread spruce blowdown. Spruce beetle lightly attacked 20 mature, water-stressed Sitka spruce near Yakoun Lake on Graham Island in the Queen Charlotte Islands. This is the largest recorded number of standing trees attacked on the Islands in 70 years. However, the majority of the broods were pitched out or had not developed successfully.

Spruce beetle attacked 15 standing and eight felled mature spruce between km 70 and 83 on the Haines Road between the Yukon and Alaska borders in the Prince Rupert Region. In the third year of beetle attacks in the area, the number of beetle-killed trees has declined from 300 in 1983. This follows a CFS-FIDS and Canada Public Works cooperative program of marking and individual tree removal to reduce populations in trees injured by a road improvement project. Moderate populations of a secondary bark beetle, *Polygraphus rufipennis* infested bark strips of felled and partially peeled trees in the area.

In the Nelson Region, scattered pockets of mortality of mature spruce increased to 250 ha in the second year of infestation at the southern boundary of Glacier National Park. Surveys indicated 7% of the spruce in the area were attacked in 1984 and 9% in previous years. A predominantly two-year cycle population will emerge in 1985 and threaten mature spruce stands mostly in the park. Elsewhere in the Nelson Region widespread infestations increased from 1 700 ha to 3 700 ha. Most infestations were associated with previously

beetle-infested areas at Top of the World Provincial Park and Upper Bull River Valley in the East Kootenay, and in the Upper Arrow Lake drainage including the upper Duncan River Valley in the West Kootenay.

Localized areas of recently killed spruce in the Kamloops Region expanded twofold to 700 ha. The largest areas were in Connel (240 ha) and McGillivray creeks (245 ha) north of Anderson Lake. New spot infestations developed in scattered areas in the Upper Adams and North Thompson river drainages; east of Vernon and north of Chase.

Spruce engraver beetle *Ips perturbatus*

This beetle, which normally breeds in slash and tops of mature spruce beetle-killed trees, attacked and killed tops of mature standing green trees adjacent to spruce beetle-infested stands east of Prince George. The highest incidence of top mortality was widespread in the McGregor and Torpy river valleys, where more than 3000 mature spruce were affected, particularly in the Pass Lake area. Top-killed trees were also common, but less numerous, in the Bowron River drainage.

Spruce aphid *Elatobium abietinum*

A second consecutive year of continuing high aphid populations resulted in scattered mortality and moderate to severe defoliation of seedlings, immature and mature Sitka spruce throughout the Queen Charlotte Islands and to a lesser degree in coastal areas between Prince Rupert and Port Edward. In two plantations on Moresby Island 4% of the immature trees were killed and 2% of the recently planted seedlings on Graham Island were killed. Tree mortality, particularly of immature open growing spruce can be expected to increase in the Region in 1985 if high populations and severe defoliation continue. Increased populations on Vancouver Island severely defoliated seed orchard trees near Victoria, and light to moderate defoliation of shoreline spruce was common in coastal areas from Jordan River to Campbell River and between Ucluelet and Tofino.

A spruce budworm
Zeiraphera vancouverana

Increased populations lightly defoliated lateral and terminal buds of valley bottom, immature and mature spruce in the Skeena River Valley from Exchamsiks to Prince Rupert. Since the 1950s, three previous outbreaks in the western part of the Region and on the Queen Charlotte

Islands, each of about five years duration, resulted in dead buds and deformed laterals and terminals, particularly on immature trees.

On Vancouver Island 40 to 60% of the buds were infested on most shoreline spruce between Long Beach and Tofino, and light populations were common in coastal stands in the Port Renfrew area near Campbell River.

DOUGLAS-FIR PESTS

Western spruce budworm
Choristoneura occidentalis

About 62 000 ha of immature and mature Douglas-fir forests in the province, mainly in the Kamloops and Cariboo regions and a localized area in the Nelson Region, were defoliated by the budworm in 1984 (see map 3), down from 73 550 in 1983.

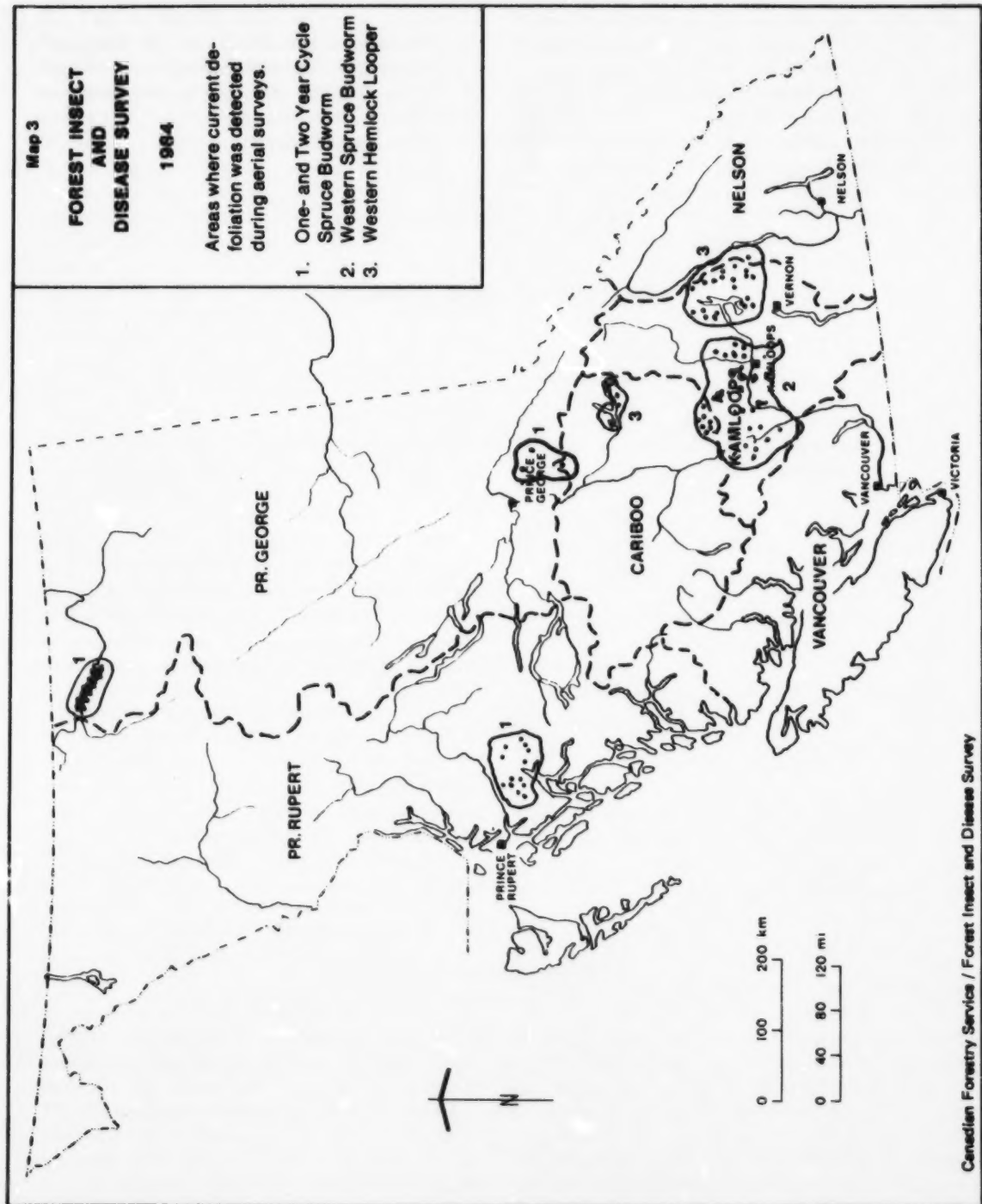
Most of the 43 000 ha of mainly light and moder-

ate defoliation in the Kamloops Region was in the Kamloops Lake — North Thompson River area. Patches of light to moderate defoliation occurred on 2 150 ha in the Lillooet area, but outbreaks in the Cache Creek-Ashcroft-Savona areas declined to 900 ha following 10 to 12 successive years of moderate to severe defoliation. Very low larval budworm populations were recorded for the first time in stands defoliated by Douglas-fir tussock moth in the Monte Lake area.

Table 3. Western spruce budworm adults in pheromone traps, egg mass counts and predicted defoliation in 1985 in the Cariboo, Kamloops and Vancouver regions.

Region	No. of stands sampled	Avg. No. adults per trap at 0.1% concentration	No. egg masses /10m ² of foliage	Predicted defoliation 1985 ¹
Cariboo	4	—	324	severe
Kamloops	9	72	57	moderate
Vancouver	12	14	—	nil
TOTAL	25			

¹ Up to 50 egg masses per 10 m² foliage = light defoliation
51 to 150 egg masses per 10 m² foliage = moderate defoliation
More than 151 egg masses per 10 m² foliage = severe defoliation



Outbreaks in the Cariboo Region continued for the fifth consecutive year, expanding slightly to 18 800 ha from 18 500 ha in 1983. Defoliation intensities generally declined to light and moderate defoliation on 17 000 ha in the Clinton area, and severe pockets on 1 800 ha in the Bonaparte River-Loon Lake areas. In the Fraser River drainage west of the major outbreak, populations declined to endemic levels.

On average, 6% (range 1 to 8%) of the mixed age class Douglas-fir in three permanent study areas near Savona, Cache Creek and Clinton, were killed by repeated years of moderate to severe budworm defoliation. Leader mortality, branch and bud dieback affected up to 50% of the understory trees in stands severely defoliated for two or more years near Spences Bridge, Ashcroft, Cache Creek and Savona.

In the Nelson Region light defoliation of the current years foliage of immature Douglas-fir declined to only 100 ha at Johnston Creek Provincial Park. Populations remained low in previous outbreak areas in the Fraser Canyon, Hope, Skagit and Manning Park areas of the Vancouver Region and little change is expected in 1985.

The increased number of larvae in beating samples, adults in pheromone traps and egg counts in 25 locations in three regions indicate continuing populations and defoliation in 1985 (Table 3). Douglas-fir stands west of Clinton are expected to be the most severely defoliated, and moderate defoliation is expected in the Kamloops Lake and North Thompson River Valley areas. Very light defoliation could occur at Johnstone Creek, but none is expected in the Vancouver Region.

Larval populations were infected by a nuclear polyhedrosis virus in five of eight infested stands between Lytton and Savona. Nine percent (2 to 24%) of the sixth instar budworm larvae were infected.

Douglas-fir tussock moth *Orgyia pseudotsugata*

After three successive years of defoliation of mature and immature Douglas-fir forests, mainly in the Kamloops Region, populations collapsed. Current, moderate and severe defoliation occurred only over 160 ha near Cherry

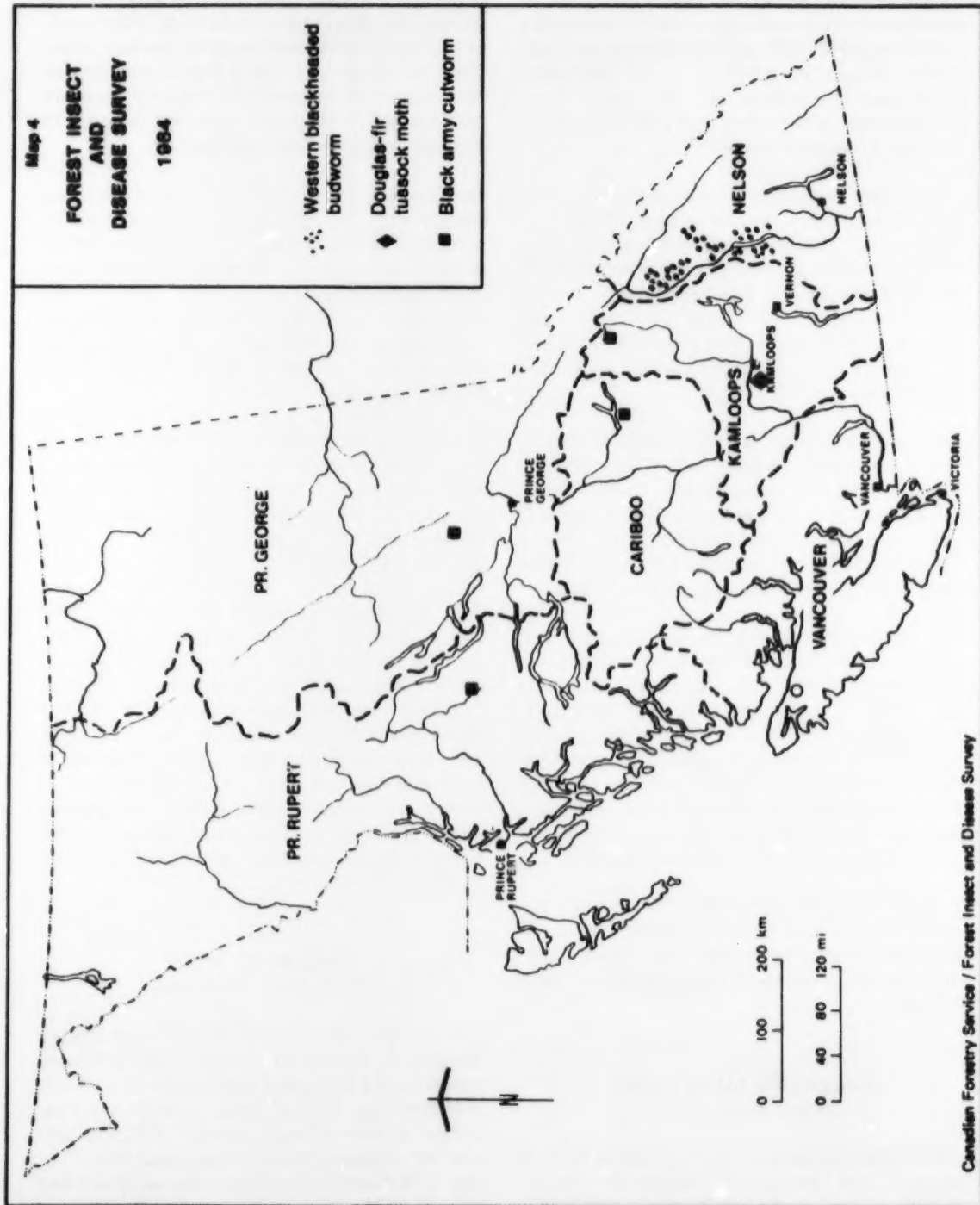
Creek west of Kamloops (see map 4), down from 23 475 ha in 1983. Small numbers of larvae (less than 35 per sample) were collected near Spence's Bridge, but there was no defoliation. Elsewhere, in previously defoliated stands in the Kamloops, Cariboo, Nelson and Vancouver regions populations collapsed. As predicted, the high incidence of a nuclear polyhedrosis virus and parasites in 1983 was a major factor in the decline.

Defoliation is not expected to occur in 1985. Egg masses were not detected in or adjacent to the defoliated stands at Cherry Creek. The average number of moths in pheromone-baited traps again declined in the Kamloops Region. In the Thompson River and Okanagan-Similkameen average numbers declined to three and less than one adult per trap respectively from 68 and 15, in 1983.

Tree mortality in previously defoliated stands was mapped in 47 areas totalling 5 500 ha in the Kamloops Region. About 3 300 ha containing mortality of young trees occurred near Cache Creek and 2 200 ha near Kamloops, Pritchard and Monte Creek. In 16 defoliated, 2 to 50 ha stands mortality of immature trees averaged 35%. The highest incidence was at Monte Creek where all immature trees over more than 50 ha were killed. Near Cache Creek 90% of the Douglas-fir regeneration was killed over 30 ha. High mortality also occurred in stands at Hefley Creek and Cherry Creek. On the other hand, 90% of the mature trees in a study area south of Clinton recovered after two to three years of severe defoliation. Trees in most moderately defoliated stands are expected to recover but the larger trees are potentially susceptible to attack by Douglas-fir beetle.

Douglas-fir beetle *Dendroctonus pseudotsugae*

The number and area of recently killed mature Douglas-fir mainly on tussock moth defoliated stands in the Kamloops Region and in scattered pockets in the Nelson, Prince George and Vancouver regions declined to about 1 375 ha. Extensive harvesting and trap tree programs from Clinton to Williams Lake reduced the incidence and area of 1984 attack in the Cariboo Region, but light scattered mortality occurred over 1 300 ha in the Fraser River drainage from Quesnel to Wil-



liams Lake and south of Alexis Creek.

From 5 to 60% of the trees (avg. 29%) were attacked in 6 of 30 stands previously defoliated by Douglas-fir tussock moth from Hedley to Cache Creek. The highest frequency was at Stump Lake south of Kamloops. Groups of 5-20 mature trees were killed in six areas in Adams, Shuswap and Mara lakes drainages in the Kamloops Region. Pockets of 5 to 100 recently killed mature trees occurred in 20 areas in the West Kootenay from Boundary Creek to Kootenay Lake and near Premier Lake. In the Blackwater Creek area near Prince George, 400 trees were attacked. In the Vancouver Region scattered attacked trees totalled 530 near Pemberton, in the Fraser Canyon area and in Strathcona Park.

Needle diseases

Infection of Douglas-fir needles by *Meria* sp., *Rhabdocline pseudotsugae*, and Swiss needle cast, *Phaeocryptopus gaeumannii*, increased in immature natural stands and seed orchards in the Cariboo, Nelson and Vancouver regions. The increased infections are attributed to wetter than normal conditions in the 1983 spring, and similar conditions this spring could result in similar or increased levels of infection in 1985.

Very light infection of the needle disease *Meria laricis*, common on western larch, was identified for the first time on Douglas-fir in a seed orchard on Vancouver Island. Swiss needle cast was common but light on older needles in young Douglas-fir stands on Vancouver Island and the Vancouver Mainland.

Up to 50% needle loss due to *Rhabdocline* needle blight occurred in natural stands over much of the eastern Cariboo Region. In the Nelson Region 25% of the year-old needles were affected by the blight over areas of 1 to 1 000 ha from Fernie to Creston. Severe infections were extensive in patches of immature Douglas-fir stands in the Bull and White river drainages near Cranbrook and south of Elko.

Western false hemlock looper

Nepytia freemani

Infestations in Douglas-fir stands in the Shuswap Lake-Salmon Arm area collapsed after three years of infestation, and after one year near Invermere and Radium. The high incidence of a naturally occurring nuclear polyhedrosis virus, which affected nearly 75% of the early instar larvae in the Kamloops Region in 1983, was a major factor in both regions.

ALPINE FIR PESTS

Budworms

Choristoneura biennis
Choristoneura fumiferana
Choristoneura orae

One- and two-year cycle budworms defoliated 12 200 ha of fir-spruce stands in the Prince George and western part of the Prince Rupert regions (see map 3), down significantly from 162 000 ha in 1983. Populations in previously defoliated stands in the interior of the Prince Rupert Region collapsed from 152 000 ha of light

to severe defoliation in 1983, and declined to 200 ha in each of the Cariboo and Nelson regions.

The major increases were in the Liard River Valley in the Prince George Region where a new outbreak of eastern spruce budworm *C. fumiferana* lightly defoliated current year's needles of valley bottom alpine fir-spruce stands over 7 300 ha between Km 790 and 863 on the Alaska Highway. Repeated severe defoliation in the area during outbreaks between 1957 and 1977 resulted in tree mortality, topkill and growth loss.

Light to moderate defoliation of current needles by *C. orae* expanded to 2 700 ha in scattered stands in the Kitimat and Wedeene river valleys in the western part of the Prince Rupert Region, up from 300 ha in 1983.

Very light current defoliation by *C. biennis* occurred over 1 500 ha of previously defoliated fir-spruce stands in the Bowron River Valley in the Prince George Region. In nearby Everett Creek, where 300 ha were lightly defoliated, a pathogen *Beauveria bassiana* and a polyhedrosis virus affected 16% and 7% of the larvae, respectively. This could reduce populations in the area in 1985. About 200 ha of fir-spruce stands defoliated in 1983 in the Willow and Big River drainages, north of Barkerville in the Cariboo Region, were again lightly defoliated. In the Nelson Region, populations in two stands in the West Kootenay area, first recorded in 1983, lightly defoliated 200 ha, and two localized infestations collapsed from undetermined causes.

Two-year cycle budworm populations in the Nass, Bell-Irving, Babine, Upper Skeena and Kispiox river valleys in the Prince Rupert Region almost collapsed. Only 10% of the buds were infested compared to 50% in 1983, and larvae per beating collection numbered less than 15 compared with up to 300 in 1983. Development was delayed by cool, wet conditions. The decline was attributed in part to the high incidence of the pathogen *B. bassiana* in 1983.

Fall egg mass surveys indicate light defoliation could occur in 1985 in the Kitimat area, and light to moderate bud feeding by off-cycle budworm in the Willow and Bowron river drainages.

Western balsam bark beetle

Dryocoetes confusus

Mortality of mature alpine fir killed by the beetle and the associated fungus *Ceratocystis dryocoetidis* occurred over 35 200 ha province-wide, up from 3 000 ha in three regions in 1985. The apparent increase was mostly in the Bulkley-Morice T.S.A's in the Prince Rupert Region, and largely due to aerial coverage of chronically infested stands not routinely surveyed. Areas of recent tree mortality in widespread high elevation stands in the Cariboo, Kamloops, Nelson and Prince George regions averaged 2 500 ha, up

slightly from 1983.

Shoot blights

Delphinella spp.

Increased infections killed current years buds and severely discolored 1984 needles of most age classes of alpine fir from Prince George to McLeod Lake. The most severely affected stands were from Bear Lake north to Carp Lake where up to 80% of the 1984 buds were killed.

Balsam woolly aphid

Adelges piceae

In response to the recent reporting of the aphid in Idaho, grand fir and alpine fir at 8 sites in the Nelson Region adjacent to the Canada-USA border were surveyed for the aphid but none was found. There has not been any significant change in the distribution of the pest in southwestern British Columbia.

Fir coneworm

Dioryctria abietivorella

Increased populations lightly defoliated upper crowns and leaders of most age classes of amabilis fir in mixed stands near Kelsey Bay, Schoen Lake and Northwest Bay on Vancouver Island. Although the coneworm is usually associated with cone damage, shoots, foliage, stems, grafts and rust galls are mined periodically.

HEMLOCK PESTS

Western hemlock looper

Lambdina f. lugubrosa

Despite a population collapse in the Nelson Region, 13 350 ha of western hemlock and western red cedar stands were lightly and moderately defoliated in 40 separate infestations in the Kamloops and Cariboo regions, (see map 3).

Infestations in the Shuswap-Mabel lakes-Seymour River drainages in the Kamloops Region almost doubled to 8 000 ha of mainly light defoliation. Conspicuous light and moderate defoliation over 5 250 ha occurred near Quesnel Lake, following a two-year population buildup. Near the south end of Canoe Arm in the Prince George Region populations collapsed following one year of severe defoliation over 850 ha. As predicted, outbreaks in previously defoliated old growth western red cedar — western hemlock stands in the Revelstoke-Arrow lakes area in the Nelson Region collapsed to only 100 ha in three locations, down from 37 250 ha in 1983.

The one- to three-years of moderate to severe defoliation in mainly old growth stands has resulted in 2 to 3 m topkill at Blanket and Cranberry creeks and Red Rock peninsula.

Moderate to severe defoliation is forecast in 1985 near Quesnel Lake, based on the number of viable eggs (47) in 100 gram lichen samples. However, the reduced number of eggs (range 1-15 per sample) at four sites in the Kamloops and Nelson regions will result in only trace or light defoliation. The decline is largely due to parasitism of overwintering eggs by the wasp, *Teleonomus* sp., and infection of larvae by a nuclear polyhedrosis virus which affected 38% of the larvae at Scotch Creek near Chase. Larval parasitism by *Diptera* and *Hymenoptera* was 51% at Scotch Creek and 10% at Quesnel Lake.

Western blackheaded budworm

Acleris gloverana

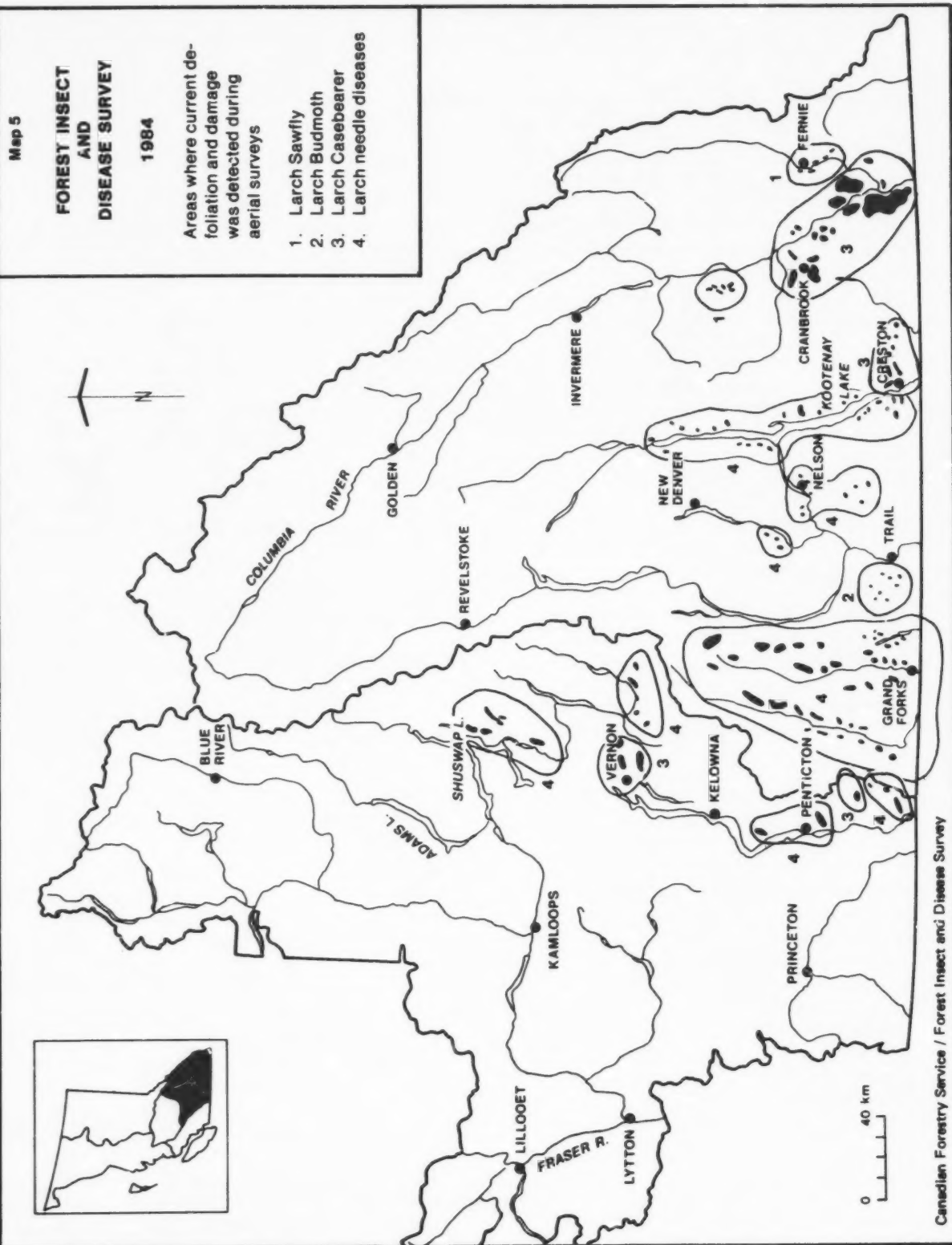
More than 19 000 ha of old growth western hemlock in 240 areas were lightly to moderately defoliated with some severe pockets in the Revelstoke and Glacier National Park areas in the Nelson Region (see map 4); up from 120 ha in 1983. The predicted increase followed a three-year buildup of blackheaded budworm populations in stands previously defoliated by western hemlock looper. Moderate to severe defoliation occurred over 2 500 ha in the Revelstoke-Glacier National Park area, where up to 40% of the crowns over 750 ha were severely defoliated at Bostock Creek. Populations collapsed after two years of light defoliation of fir-spruce stands along Dewar Creek west of Kimberley.

Overwintering egg populations at five infested stands in the Revelstoke area ranged from 1 to 19 eggs (avg. 9) per 50-cm branch. Egg counts and large moth flights indicate continuing populations in 1985. Increased blackheaded budworm larval populations in stands previously defoliated by hemlock looper in the Kamloops Region indicate a potential for light defoliation in 1985.

Terminal crook disease

Colletotrichum acutatum

The pathogen was not found on western hemlock seedlings in three plantations near Northwest Bay on Vancouver Island, during the fourth inspection since the stock was outplanted in 1981. Inspections were initiated following the discovery of the introduced disease on seedlings in a lower mainland nursery.



LARCH PESTS

Larch casebearer *Coleophora laricella*

Casebearer populations, delayed up to three weeks by cool moist spring weather, still intensified in most western larch stands in the Nelson Region and to a lesser degree in adjacent areas of the Kamloops Region. Light to severe defoliation covered 41 000 ha north of the United States-Canada border from Elko north to Kimberley and west to Kootenay Lake (see map 5), down from 60 000 ha in 1983. The most severe defoliation was in the Cranbrook, Jaffray, Elko and Kookanusa Lake areas. Light to moderate defoliation was common from Elko to Kimberley, Yahk to Creston, and light from Rock Creek to Bridesville and Anarchist Mountain east of Osoyoos. Small population increases north of Osoyoos and east of Vernon lightly defoliated small patches of western larch.

Although spring larval populations declined, assessments of overwintering populations at 11 sites in the Nelson and Kamloops regions indicate light to severe defoliation of western larch stands will occur in 1985. Based on the number of larvae per 100 fascicles (avg. 36, range 3-143), severe defoliation is forecast at Anarchist Mountain, east of Osoyoos; moderate defoliation near Cranbrook, Jaffray and east of Okanagan Falls, and light defoliation at Kookanusa Lake, Creston, Salmo and near Castlegar.

Pheromone-baited traps to monitor casebearer populations in 16 sites in the Nelson Region and four in the Kamloops Region, mainly beyond the known limits of casebearer infested stands attracted an average of 84 adults (range 0-3000+). Studies continue to determine the significance of the number of adults. Trap data indicates a northward migration within the host range, particularly in the West Kootenay.

The larval parasite, *Chrysocharis laricellae* was released in two casebearer-infested stands in the East Kootenay as part of a continuing biological control program. Two hundred and forty male and female adults were released near Fairmont

Hot Springs in mid-June and 537 near Cranbrook in mid-August. Introduced from Austria, the parasite has contributed to the decline of previously high casebearer populations in the West Kootenay. Less than 4% of the pupae from 20 sites in the Nelson and Kamloops regions were affected by parasites, the majority of which were *Agathis pumilla* (47%) and *C. laricellae* (28%).

Larch sawfly *Pristiphora erichsonii*

Sawfly populations in western larch stands in the East Kootenay area of the Nelson Region declined significantly in the third year of infestation. The area defoliated declined by a third to 3 000 ha in 20 areas of mainly light defoliation, with moderate to severe pockets over 750 ha in the Elk River Valley west of Fernie to Morrissey, and in the Lost Dog Lake and Skookumchuck Creek areas, (see map 5). Although consecutive years of severe defoliation would probably result in growth loss, there has not been any evidence of branch or tree mortality.

The predicted widespread decline in the Sparwood, Fernie, and Elko areas was attributed to several natural control factors including parasitism and rodent predation of overwintering pupae. A general population decline is expected to occur again in 1985, based on the reduced number (range 6 to 65, avg. 33) of overwintering cocoon in 100 cm² duff samples from 3 infested stands.

Defoliation of eastern larch stands 80 to 120 km north of and near Watson Lake in the Yukon were reported by Yukon Lands and Forests. This was the first indication of increased sawfly populations in the Territory since 1954.

Larch budmoth *Zeiraphera improba*

Outbreaks in western larch stands in the Nelson Region, particularly in the East Kootenay, de-

clined significantly to 1 100 ha. In 1984 only 10 areas (see map 5) were moderately defoliated, compared to 6 600 ha in 36 areas in 1983. In the West Kootenay budmoth populations were delayed by about two weeks by cool moist conditions, but lightly to moderately defoliated 975 ha of mature larch in the Blueberry-Paulson creeks area west of Trail, for the first time. A second year of feeding severely defoliated 125 ha near Rossland. Unconfirmed aerial observations indicated light populations at Vance Creek north-east of Vernon where severe defoliation occurred over 500 ha in 1973-74. The cause of the decline of numerous small infestations in the East Kootenay is not known but is similar to the rapid decline after one year of defoliation in the previous four outbreaks since 1965.

Larch needle diseases

Meria laricis, *Hypodermella laricis*

Following wetter than normal conditions during the 1983 infection period, widespread infections of all age classes of western larch in the Nelson Region and part of the Kamloops Region by both diseases (see map 5) were more severe and extensive than in 1983. The more prevalent fungus around Creston and in the western portions of the West Kootenay was *M. laricis*. From Bridesville to Salmo and in the Kettle and Slokan river valleys up to 80% of the foliage on most larch,

particularly immature trees, was infected by both fungi. Similar damage in stands up to 1 000 ha occurred from Crawford Bay to Yahk and Skookumchuck in the East Kootenay.

Moderate to severe infections of *H. laricis* were widespread in the host range east of the Okanagan Valley, from Osoyoos to Anstey Arm on Shuswap Lake.

Infection of mature trees was usually limited to the lower half or third of the crown but whole crowns of many immature trees were severely infected. Except for undetermined increment loss and seedling mortality, tree recovery is usually rapid unless subjected to repeated severe infections.

European larch canker

Lachnellula willkommii

Surveys for this canker disease during the past four years have been negative. Potentially damaging to all age classes of western, alpine and eastern larch forests, it is currently limited to New Brunswick, Nova Scotia and some eastern states. Although surveys were negative, two saprophytic fungi *Lachnellula* spp. were collected on western larch in southeastern British Columbia in 1984.

MULTIPLE HOST PESTS

Root and stem rots

Mortality of spruce, Douglas-fir and pine caused by root diseases such as *Polyporus tomentosus*, *Armillaria (mellea) ostoyae*, *Verticicladiella wagneri* and *Phellinus weirii* is widespread throughout British Columbia.

Infection of mature spruce by *P. tomentosus* in 28 surveyed stands in the Prince George and north-

ern Prince Rupert regions and the Yukon ranged from 0 to 100% (avg. 35%). The highest average incidence, (40-100% of the trees infected) occurred in nine stands from McLeod Lake east to the Holmes River Valley, at Pine Pass (55%), and in Horseshoe Bay campsite in Kluane National Park in the Yukon where 33% of the spruce were infected. In 13 stands in the Blackwater, Vanderhoof, and Fort St. James areas and 4 stands near Cassiar 0-40% of the trees were

infected. Advanced decay was evident in recently windthrown mature spruce along access roads and cut block fringes northwest of Ft. St. James.

An estimated 5% of the 13- to 24-year old spruce in nine plantations in the Kispiox River to Dabine Lake area in the Prince Rupert Region were infected by *P. tomentosus*. Many of the most severely infected trees were adjacent to old infected spruce stumps. In older natural spruce stands, 7% of the trees in three stands were infected in the Morice River drainage and near Houston. In the upper Bell-Irving valley less than 5% of the mature spruce in three stands were infected, and there was evidence of the disease in one of three stands in the Kinskuch River drainage north of Aiyansh.

A survey of the Sechelt Campground area in Roberts Creek Provincial Park in the Vancouver Region indicated 4% of the mature western hemlock and Douglas-fir were killed or infected by root, stem or heart rots. *Phellinus* root rot was the most prevalent on Douglas-fir, and *Armillaria* root rot on western hemlock.

P. tomentosus infected Engelmann spruce in two stands near Quesnel Lake in the Cariboo Region. In the Chilcotin and Nazko areas a high incidence of red ring heart rot, *Phellinus (Fomes) pini* was associated with widespread windthrown lodgepole pine.

Black army cutworm

Actebia fennica

Newly planted conifer seedlings were lightly to severely defoliated by the cutworm in 6 of 27 recently burned sites in the Prince Rupert, Prince George and Cariboo regions (see map 4) down significantly from 200 000 seedlings damaged or killed in 35 sites in 1983.

Despite the general decline, mainly from a nuclear polyhedrosis virus, larvae mined 30 to 35% of the spruce buds on seedlings near Telkwa and Houston, and delayed planting at a third site. Elsewhere in the Prince Rupert Region, defoliation was limited to herbaceous ground cover, mainly fireweed.

Newly planted white spruce seedlings on recently burned areas near Davie and Weedon lakes in

the Prince George Region were severely defoliated. There was no evidence of larvae in more than 30 plantations affected by the cutworm in the region in 1983. The incidence of a nuclear polyhedrosis virus and parasitism of larvae and pupae reared by B.C.M.F. and submitted to PFRC from near Bear Lake, north of Prince George, was 66% and 23% respectively. The parasites included *Nowickia latigena* (Tachinidae) and *Eutenyacra suturalis* (Ichneumonidae).

Increased populations damaged up to 20% of the buds of newly planted Engelmann spruce and Douglas-fir seedlings in two recently burned sites near Mitchell Bay on Quesnel Lake in the Cariboo Region. In an adjacent provenance trial 25% of the Douglas-fir seedlings were lightly defoliated but bud damage was minimal.

Larval feeding was limited to herbaceous ground cover at four sites in the North Thompson River drainage in the Kamloops Region.

More than 135 baited traps at 39 sites in three regions where cutworm larvae were active, attracted an average of 10 adults per trap (range 1 to 39). The highest numbers per trap, 39, were at Weedon Lake in the Prince George Region. Between Smithers and Burns Lake moths were trapped in 31 sites with the highest concentrations near Smithers Landing. Based on the number of pupae (0.4 to 11) per sample and adults in traps, populations could occur in most recently burned sites in the Prince Rupert Region scheduled for 1985 planting. Only single moths were trapped in each of three areas in the North Thompson River Valley. The significance of the numbers of moths per trap, beyond identifying their presence continues to be studied.

Rodents

Tree mortality, topkill and severe debarking of lodgepole pine and western hemlock by rodents including porcupines, voles and snowshoe hares increased in the Nelson, Prince Rupert, Kamloops and Vancouver regions.

Porcupines killed 15% and debarked 35% of the lodgepole pine regeneration in numerous small patches and top-killed 3% of the trees in a 50 ha site southwest of Cranbrook. At Hanna Creek near Rossland up to 50% of the intermediate

western larch were top-killed. West of Terrace at Dasque Creek, 20% of the 10- to 30-year old western hemlock trees and 40% of the terminals were killed over 35 ha. Similar incidences of porcupine debarking have occurred periodically in spruce regeneration in parts of the Prince Rupert Region since 1976. Damage to single scattered conifers increased generally throughout the Prince Rupert Region.

In the Nelson Region, debarking of dwarf mistletoe-infected lodgepole pine branches by squirrels at Dewar Creek affected 90% of the trees over 30 ha.

Feeding attributed to snowshoe hares killed 5% and caused partial basal girdling of 95% of the young spaced lodgepole pine over 20 ha at Skull Creek northwest of Kamloops.

Increased vole populations (up to 50 per ha) debarked 40 to 70% of the stems of 5- to 10-year old Douglas-fir in plantations on Texada Island.

Climatic injury

Frost during bud flush in late May killed up to 70% of the terminal and lateral buds of immature and seedling conifers in localized areas in the Prince George, Prince Rupert, Kamloops and Vancouver regions. Terminal and lateral bud mortality averaged 2% and 16% respectively, on 10- to 16-year old spruce in five plantations in the Kispiox-Babine Lake area in the Prince Rupert Region. Up to 70% of the buds were killed on most spruce in a natural stand at Tumuch Lake and near Pilot Mountain in the Prince George Region. Elsewhere about 5% of the lateral buds of mature planted and natural Douglas-fir were killed in localized stands in the Fraser Canyon, east of Hope, and on Bowen Island. Approximately 50% of the buds on mature Douglas-fir were killed in two stands near Barnes Lake near Ashcroft. At Surrey some Douglas-fir, Sitka spruce and western red cedar seedlings were severely affected by late frost.

Cone and seed pests

Cone crops in coastal and interior stands were greatly reduced from 1983. This resulted in in-

creased infestations by cone and seed pests which severely affected the light scattered Douglas-fir and white spruce cone crops in interior stands.

Most of the Douglas-fir cones (avg. 94%, range 78 to 100%) in four areas in the East Kootenay were infested and 26%, (range 12 to 38%) in six stands in the West Kootenay of the Nelson Region. The major pest was a cone moth, *Barbara colfaxiana* with lesser amounts of a cone gall midge, *Contarinia oregonensis*, a cone scale midge, *C. washingtonensis* a cone moth, *Diorctria abietivorella* and a seed chalcid, *Megastigmus spermatotrophus*.

A cone disease, *Sirococcus strobilinus* infected 65% of the very light scattered white spruce cones at Chetwynd in the Prince George Region. Inland spruce cone rust, *Chrysomyxa pirolata* infected 4% of the Engelmann spruce cones near Nakusp in the Nelson Region and 25% of the white spruce cones at the Skimikin seed orchard near Salmon Arm.

Acid rain monitoring

Unprecedented tree mortality and foliar damage in Europe and some locations in eastern North America has increased the attention on acid rain and airborne pollutants. The relationships between acid rain and frost damage have not been clearly demonstrated. Direct action of the pollutants on the cuticle of the foliage may occur, perhaps influencing subsequent frost damage or insect and disease attacks. Slight changes in soil pH may affect mycorrhizae, increase solubility of toxic elements or leach necessary elements from the soil.

With rainfalls as low as pH 4.6 being recorded when storm fronts move into southwestern B.C. through the Puget Sound, and with the existence of some sensitive soils of low buffering capacity, the potential of forest damage in western North America is also recognized.

To obtain baseline knowledge of the concentrations of foliar and soil elements, foliar condition and tree growth, and to detect and monitor possible changes, a nationally standardized series of forest plots are being established. These constitute the CFS-FIDS Acid Rain National Early Warning System (ARNEWS). To date, three

such permanent plots have been established in British Columbia; near Shawnigan Lake, on Salt-spring Island and on the UBC Research Forest. These areas were selected in part because of the availability of other related information such as tree growth, water quality and soil chemistry. Additional plots will be established in 1985 and 1986.

To obtain a more immediate assessment of the condition of the forest in B.C., FIDS rangers made additional observations at 417 permanent sample sites (PSS) throughout the province. Particular attention was directed to symptoms reported to be typical of acid rain damage in Germany, namely: casting of green or uncharacteristically shaped leaves, premature discoloration and shedding of needles, unexplained die-back, early flattening of tree crowns ("siorks nesting"), abrupt decline in foliage or annual ring growth, etc. Site assessments were distributed among the soil sensitivity zones with 19% low, 17% moderate, and 64% high. Site distribution by wet sulphate deposition zone was 17% with 20-30 kg/ha/yr, 17% with 10-20 level and 66% less than 10.

Trees were healthy in 80% of the PSSs. In 20% of the sites, mainly in the West Kootenay, trees had thin crowns (frequently due to current or recent insect feeding or needle casts) or flat tops usually associated with stand maturity. Some level of insect or disease activity was recorded on 40% of the sites. At least 20 tree species and numerous ground cover species were observed. Needle retention averaged three to five years, generally depending on species. Although long term or indirect effects may be accumulating, all obvious damage encountered could be accounted for by current or previous pest conditions.

Stand improvement assessments

In support of the Environment 2000 projects administered by the C.F.S., pest conditions were assessed at 17 sites in the Kamloops, Nelson, Prince Rupert and Vancouver regions.

Major pest problems found at sites near Enderby, Golden and Powell River were all root rots.

A brown cubical butt rot, *Polyporus sericeomollis* infected 90% of the 40-year-old western red

cedar on about 6 ha of a 29 ha spaced, mixed stand near Enderby. More than 50% of the heartwood was decayed at the butt level of most trees. Removal of infected standing cedar and replacement with other species including lodgepole pine, was recommended.

About 50% of the mature Douglas-fir in mixed stands in the Blackwater area north of Golden were infected by *Armillaria* root rot, *Armillaria (meliea) ostoyae*, first identified as a problem in the area in 1979. Western larch, which is less susceptible to *A. meliea* infection, has now been planted in the infected stands.

Lightly infected by *Phellinus weirii*, small pockets of 60-year-old Douglas-fir were evident in mixed conifer stands adjacent to an access improvement project near Powell River. Some blowdown may occur.

Pests of less or little concern were observed at 9 sites in the Kamloops, Nelson, Prince Rupert and Vancouver regions. Light infections of western hemlock dwarf mistletoe, *Arceuthobium tsugense* were culled from 35 ha in a spaced mixed stand near Comox, successfully controlling infection. Natural stands near an access improvement project near Powell River were lightly infected by the mistletoe. Sitka spruce weevil, *Pissodes strobi* in 2% of the leaders of 12- to 15-year-old trees in two spaced stands near Kitimat and Terrace could intensify and should be monitored. A root collar weevil, *Hylobius warreni* in less than 1% of the 7-year-old spaced lodgepole pine stand near Golden could increase following the spacing. A pruning control program of lodgepole pine dwarf mistletoe, *Arceuthobium americanum* was satisfactorily initiated near Merritt. Pine needle diseases, *Lophodermella* spp. moderately infected up to 30% of the 1983 needles of most residual lodgepole pine in two spaced stands near Golden. About 2% of the branches of residual 5-year-old lodgepole pine in a 30-ha spaced stand near Canal Flats were infected by western gall rust, *Endocronartium harknessii* which could have been removed during spacing. In an adjacent spaced mixed stand, Rhabdocline needle disease *Rhabdocline pseudotsugae* infected up to 40% of the 1983 needles on most trees. Swiss needle cast, *Phaeocryptopus gaeumanii* lightly infected older needles on 10% of the spaced immature Douglas-fir in a mixed 35-ha stand near Comox. Foliar diseases, while decreasing growth, should not be

serious unless repeated and severe over several years.

The majority of the implemented stand treatments were generally satisfactory at the time of

examination. However, increased recognition of forest pests, particularly perennial diseases in young stands scheduled for spacing, could prevent spread of infection and enhance the quality of residual trees.

DECIDUOUS AND ORNAMENTAL TREE PESTS

Tent caterpillars

Malacosoma disstria, *M. californicum pluviale*

Forest tent caterpillar, *M. disstria*, populations defoliated 30 700 ha of trembling aspen stands in the Prince George, Prince Rupert and parts of the Nelson Region, but collapsed in the Cariboo Region. Western tent caterpillar *M. c. pluviale* infestations north of Terrace declined to 900 ha. Localized colonies were widespread in the Fraser Valley and south and east coastal Vancouver Island.

Defoliation by forest tent caterpillar was mainly moderate to severe over 29 700 ha in the Salmon River Valley and Peace River in the Prince George Region for the second consecutive year. Mainly light to moderate defoliation with some severe pockets over 1 000 ha occurred near Moricetown, Hazelton and Kitwanga in the Prince Rupert Region. Scattered aspen and cottonwood groves and other trees and shrubs were lightly defoliated around Trail in the Nelson Region.

After four consecutive years of defoliation in the Bell-Irving River and Meziadin Lake valleys in the Prince Rupert Region, western tent caterpillar populations collapsed. The collapse is attributed to natural control factors, including parasites.

For the fourth consecutive year, colonies of western tent caterpillar severely defoliated deciduous trees and shrubs in widely scattered pockets in the Fraser Valley and southern and eastern coastal areas of Vancouver Island. Little change is expected in 1985.

Egg masses in recently defoliated stands in the Prince Rupert and Prince George regions indicate continuing moderate and severe defoliation in 1985.

Poplar shoot blights

Trembling aspen and black cottonwood stands, mainly in the Prince Rupert and Prince George regions and to a lesser degree in the Nelson and Kamloops regions, were moderately to severely infected by the shoot blights *Venturia macularis* and *V. populina*. Moist spring weather favored infection. Dead shoots and leaves were particularly common on aspen in groves in the Nass River Valley from Kitwanga to Cranberry Junction. More than half of the stands between Endako and Hazelton and in the Nass, Kispiox, Babine and Skeena river valleys were lightly to moderately infected, with numerous 1- to 10-ha patches where entire crowns were severely infected. Conditions were similar and common in the Peace River and Vanderhoof to Fraser Lake areas in the Prince George Region.

A second year of infection in the West Kootenay caused dieback of the upper crowns in 15% of the aspen from Shelter Bay to Revelstoke. Severe infection of up to 50% of the trees, usually in 1-ha or smaller groves, and a few up to 200 ha, occurred in the New Denver-Zincton area. In the East Kootenay up to 90% of the aspen stands were severely infected in the Sparwood-Flathead and Revelstoke-Golden areas. Shoot mortality was common and severe in black cottonwood groves in the Creston and Elko areas. Moderately

to severely infected groves were widespread in the Kamloops Region particularly west of Little Fort to Bridge Lake and in the Adams River Valley.

A birch leaf miner
Lyonetia saliciella

Leafminer populations in previously defoliated western white birch stands in parts of the Prince George and Nelson regions declined. Larval mining lightly discolored most birch stands in the McBride-Valemont area and severely discolored small localized immature groves east of Tété Jeune Cache to Mt. Robson. Reduced populations lightly to moderately discolored scattered birch stands in the Golden area for the seventh consecutive year. There was no evidence of branch or tree mortality in affected areas and most trees refoliated in late summer.

A birch leaf skeletonizer, *Bucculatrix canadensisella* in the Trail area collapsed after two consecutive years of severe defoliation.

Striped alder sawfly
Hemichroa crocea

For the second consecutive year, sawfly populations increased and defoliated widely distributed areas of red alder in the Queen Charlotte Islands and coastal areas of the Prince Rupert Region. Mostly light to moderate defoliation, with pockets of severe defoliation up to 5 ha, was common from Queen Charlotte City to Masset on Graham Island and occurred sporadically between Kitimat and Prince Rupert. Similar levels of defoliation are expected to continue in 1985.

Gypsy moth
Lymantria dispar

Larvae were recorded in the Courtenay area in May-June during egg-mass surveys by Agriculture Canada and 25 adults were caught in 12 pheromone-baited traps in August-October. However, none were found in 188 traps in 117 forested recreational areas throughout the province monitored by the Forest Insect and Disease survey in cooperation with Agriculture Canada. Two adults were trapped in Vancouver near the

P.N.E., one adult at Cultus Lake; four adults and 11 egg masses were found near Chilliwack, and one adult was trapped at Adams River, east of Kamloops.

Since first recorded in British Columbia in 1976 in the Lower Mainland, adults and egg masses were found in the Langley area, and for the first time on Vancouver Island in 1983 near Courtenay. Defoliation has not occurred and populations have not become established. Egg mass removal and some localized treatments were completed.

Although ornamental and urban trees could be severely defoliated as populations become established, the major forestry concern would likely be quarantine restrictions such as those recently implemented in active Gypsy moth areas in Oregon.

Egg mass surveys and pheromone trapping programs in cooperation with Agriculture Canada will continue in 1985.

Satin moth
Leucoma salicis

For the second consecutive year trembling aspen and black cottonwood groves were severely defoliated in parts of the Nelson and Kamloops regions. One- to five-ha groves were moderately to severely defoliated between Rock Creek and Bridesville, near Trail, New Denver, Summit Lake and Moyie in the Nelson Region and near Tulameen in the Kamloops Region but populations collapsed near Carpenter Lake. Satin moth larvae were common on conifer seedlings of the B.C. Ministry of Forests nursery at Harrop, east of Nelson. However, there was no evidence of damage to the seedlings. The larvae emerged from eggs laid by moths, which were attracted in large numbers by lights at the nursery site in July. Since the moth was first recorded in the Nelson Region in 1963, only deciduous hosts have been defoliated.

Western oak looper
Lambdina f. somnaria

Defoliation of mature Garry oak was light in an ecological reserve on Saltspring Island. After 5

successive years of defoliation, most trees still appear reasonably vigorous and have recovered successfully. A small number of previously defoliated mature Douglas-fir have also recovered and Douglas-fir bark beetle is no longer a threat. Vigorous but declining numbers of larvae, showing little evidence of natural control agents, indicate populations will continue in 1985 but at reduced levels.

Winter moth

Operophtera brumata

For the fourteenth consecutive year, light to severe defoliation of deciduous trees and shrubs was widespread in the Greater Victoria area, Saanich Peninsula and Western Communities, and severely affected the aesthetic value of urban trees. In the Duncan area where the pest was collected for the first time in 1983, populations increased and expanded lightly defoliating Garry oak and maple and moderately defoliated nearby fruit trees. Larvae were collected for the first time on Saltspring Island in a Garry oak stand, and two male adults were caught in a pheromone-baited trap at Nanaimo. It is not resident in the Lower Mainland or Fraser Valley.

The introduced larval parasite *Cyzenis albicans* released during 1979-82 increased significantly in 1984 affecting 44% (range 19-77%) of the winter moth populations at 33 sites in the Greater Victoria area and one site at Duncan. Based on x-ray examination of material from one location, about

2% appeared to be parasitized by *Agrypon flaveolum*. Other parasites affected about 2% of the population.

Dogwood leaf blotch, (Anthracnose)

Gloeosporium sp.

The incidence of infection of dogwood trees in the east coastal area of Vancouver Island and the Vancouver Mainland area declined slightly to about the 1982 level. Foliar discoloration on single trees and small groups of up to 10 trees was light to moderate at Peace Arch Provincial Park, Alouette Lake, in Vancouver and West Vancouver, and from Victoria to Nanaimo. Flower production was reduced in 1984, but twig or branch dieback, which could result from repeated infections, has not yet been observed.

Cypress tip moth

Argyresthia sp.

Severe discoloration and branch tip and tree mortality of ornamental cypress trees and shrubs occurred for the second consecutive year in the Greater Victoria, Duncan, Nanaimo, Port Alberni and Campbell River areas. High overwintering survival rates and population buildups contributed to the increased damage. Precluding adverse climatic conditions in 1984-85, severe discoloration and some tree mortality could be repeated in 1985. Native conifers have not been affected.